CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-99

SEPTEMBER 24, 1980

1. Name of fault

San Andreas and Harris Ranch faults.

2. Location of fault

Hollister 7.5 - minute quadrangle, San Benito County

3. Reason for evaluation

Part of 10-year evaluation program (Hart, 1980) and request by T.C. Smith, California Department of Parks and Recreation.

4. List of References

Dibblee, T.W., Jr., 1975, Geologic map of the Hollister, Gonzales, and San Benito quadrangles, California: U.S. Geological Survey Open-file Map 75-394, scale 1:62,500.

Hart, E.W., 1980, Fault hazard zones in California: California Division of Mines and Geology Special Publication 42, p. 13.

Nason, R.D., 1971, Investigations of fault creep slippage in northern and central California: unpublished Ph.D. thesis, University of California at San Diego, 231 p.

Real, C.R., Toppozada, T.R., and Parke, D.L.,1978, Earthquake catalog of California, January 1, 1900-December 31, 1974: California Division of Mines and Geology Special Publication 52.

Real, C.R., Toppozada, T.R., and Parke, D.L., 1978, Earthquake epicenter map of California: California Division of Mines and Geology Map Sheet 39, scale 1:1,000,000.

Rogers, T.H., 1973, Geologic map of the Hollister quadrangle: California Division of Mines and Geology unpublished map, scale 1:24,000.

Rogers, T.H., (in press), Geologic map of the Hollister and San Felipe quadrangles, California: California Division of Mines and Geology Special Report, scale 1:24,000. (Revision of Rogers' 1973 map)

Rogers, T.H., and Nason, R.D., 1971, Active displacement on the Calaveras fault at Hollister, California: Bulletin of the Seismological Society of America, v. 61, no. 2, p. 399-416.

Schulz, S.S. and Burford, R.O., 1979, Catalog of creepmeter measurements in central California for 1976 and 1977: U.S. Geological Survey Open-file Report 79-1609.

Smith, T.C., 1980, Recently-active faults in the Hollister Hills State Vehicular Recreation Area -- A report in compliance with the Alquist-Priolo Special Studies Zones Act: unpublished in-house report for the California Department of Parks and Recreation.

Steinbrugge, K.V. and Zacher, E.G., 1960, Fault creep and property damage: Bulletin of the Seismological Society of America, v. 50, no.3, p. 395.

Taliaferro, N.L., 1948, Geologic map of the Hollister quadrangle, California: California Division of Mines Bulletin 143, scale 1:62,500.

Tocher, D., 1960, Creep on the San Andreas fault -- Creep rate and related measurements at Vineyard, California: Bulletin of the Seismological Society of America, v. 50, no. 3, p. 396-403.

U.S. Geological Survey, 1966, Aerial photos WRD 1721 to 1736, black and white, vertical, scale approximately 1:15,000.

U.S. Geological Survey, 1966, Aerial photos WRD 1982 to 1992, black and white, vertical, scale approximately 1:12,000.

U.S. Geological Survey, 1974, Aerial photos 3-207 to 3-209, low sun angle color, vertical, scale approximately 1:36,000.

U.S. Geological Survey, 1974, Aerial photos 12-32 to 12-36, low sun angle color, vertical, scale approximately 1:20,000.

5. <u>Review of available data, air photo interpretation, and field checking</u>

The San Andreas fault zone depicted on the 1974 Special Studies Zones (SSZ) Map of the Hollister 7.5-minute quadrangle was based on fault traces by Taliaferro (1948) and Rogers (1973) (figures 1, 2). Most of the land surface along the fault has not been significantly altered by man, although areas in the Hollister Hills State Vehicular Recreation Area (HHSVRA) have been modified by road grading and offroad vehicle activity.

San Andreas Fault

The San Andreas fault in this Fault Evaluation Report (FER) study area is a complex zone of near vertical to vertical faults with right-lateral strike-slip displacement. The fault zone varies in width from 10 feet to greater than 1,000 feet (Rogers, in press; Smith, 1980; this report, figure 3). However, the most recently active traces are generally rectilinear and well-defined. Geomorphic evidence supporting right-lateral faulting, such as the 4,000-foot offset of Bird Creek, can be observed along the fault trace (figure 3).

Historic fault creep is well-documented along this segment of the San Andreas fault. Fault creep has been observed at the St. Francis Retreat along the northwestern-most trace of the fault. Fault creep at the Almaden Winery at the southeastern-most part of the fault trace has been recognized since the late - 1950's. The rate of right-lateral displacement at the winery averaged 0.5 inches per year for the period 1948 to 1959 (Tocher, 1960). Creepmeters installed by the U.S. Geological Survey are located in the winery and about 2½ miles northwest of the winery on a gently sloping stream terrace (figures 2, 3). Fault creep rates measured during the period 1976 to 1977 averaged 0.45 inches per year (Schulz and Burford, 1979). Smith (1980) reports that two small dams across Bird Creek are right-laterally warped.

The southern extent of surface fault rupture from the 1906 M8+ earthquake occurred northwest of the FER study area, near San Juan Bautista. However, reports from Harris Ranch property owners indicate that the 1906 fault trace may have extended farther southeast into the FER study area (Smith, 1980). Howard Harris, former owner of the Harris Ranch property (HHSVRA), reported seeing "the furrow in a few places when he arrived in the 1920's" (Smith, 1980). Smith does not indicate a specific location for these fault traces.

A geologic map of the Hollister 15-minute quadrangle by Dibblee was published in 1975. Dibblee depicts the San Andreas fault as a single, continuous trace that represents only a generalized location. Dibblee's (1975) fault trace will not be evaluated in this report.

Traces of the San Andreas fault based on air photo interpretation of 1966 WRD photos (USGS) and 1974 low sun angle color photos (USGS) by this writer generally agree with traces shown by Rogers (in press) and Taliaferro (1948) (figures 2, 3). The approximately located trace of Taliaferro south of the St. Francis Retreat is located within old landslide deposits and reliably cannot be followed (figure 3). Rogers' inferred and concealed trace of the San Andreas branch fault along Cienega Road cannot be followed northwest of Vineyard School (figures 2, 3). The querried fault creep locality (figure 2) along this fault trace was examined by Smith (1980) and no evidence of fault creep was observed.

Geomorphic evidence for Holocene surface faulting along the main trace of the San Andreas fault can be observed along most of the fault trace and includes scarps, closed depressions, offset streams, tonal lineaments in alluvium, shutter ridges, beheaded drainages, benches, sidehill troughs, and offset man-made features such as offset rows of grapevines (Steinbrugge and Zacher, 1960) (figure 3).

Harris Ranch fault

The Harris Ranch fault shown on the 1974 SSZ Map of the Hollister quadrangle is based on Rogers (1973) (figure 2). This fault trace is curvilinear and is generally parallel to the main trace of the San Andreas fault. The decision to zone the Harris Ranch fault was based on a moletrack observed by Rogers during field mapping in the mid-1960's (Rogers, 1973; in press; p.c., 1980). Rogers assumed this feature was related to faulting and that it may have formed in April 1961 when earthquakes of M5.6 and M5.5 occurred 10 miles southeast of the moletrack location (Rogers, p.c., 1980; Real and others, 1978). The moletrack may also have been formed by expansive fault gouge or clay seams (Rogers, p.c., 1980).

Rogers (in press) shows a parallel fault trace east of the Harris Ranch fault in a revised edition of his 1973 map (figure 4). Gravel deposits of mid-Pleistocene age (Rogers, in press) are shown to be offset by the Harris Ranch fault (figure 4). Rogers shows older landslide deposits offset right-laterally by the two traces of the fault (figure 4). However, about 2,500 feet southeast of the offset landslide deposits the Harris Ranch fault does not cut older alluvial deposits (late Pleistocene?) (Rogers, in press) (figure 4).

Interpretation of 1966 WRD air photos (USGS) by this writer indicates that the Harris Ranch fault is primarily expressed by saddles, notches, and linear drainages in Pliocene Purisima Formation (figure 4). Geomorphic evidence of recent faulting cannot be found along most of this fault trace, except for the very northwestern-most segment that joins the main trace of the San Andreas fault (figure 3). Bedding in the Purisima Formation strikes parallel to the San Andreas fault and dips steeply to the southwest near the fault (Dibblee, 1975; Rogers, in press) (figure 4). Differential erosion forms many aligned saddles, notches, and resistant ridges that control drainage along a similar trend with the Harris Ranch fault. Geomorphic and stratigraphic evidence tends to support the interpretation of differential erosion along bedding rather than faulting, although faulting along bedding planes cannot be precluded (Smith, 1980). Evidence for systematic right-lateral offset of old landslide deposits or present drainages cannot be observed on 1966 WRD air photos (USGS).

The moletrack observed by Rogers is critical in establishing the recency of movement along this fault trace. A field check of the area of Rogers' moletrack was made in early May 1980, although it was doubtful the feature would have been preserved over the intervening 15± years. The moletrack shown by Rogers is located along the base of a steep scarp that can be demonstrated to be part of an active landslide feature (figures 3, 5).

A sinuous "moletrack" about 30 to 40 feet long was observed during the field check (photo 1), and was on the location and trend of Rogers' trace of the Harris Ranch fault. The "moletrack" was very fresh and coincided with a scarplet with a vertical displacement of about 6 to 8 inches, northeast side down. Pull-apart fissures occurred along both sides of the "moletrack". The "moletrack" was located on the middle scarp/bench interface of a sequence of three scarp-graben-bench features (figure 5, photos 1, 2). Fresh pull-apart fissures adjacent to the "moletrack" and coincidence of the "moletrack" with the interface of a scarp and bench indicate that landsliding is the cause of all these features.

A possible explanation for the formation of a moletrack-like feature on a landslide is shown in figure 5. Two minor landslide slip surfaces and associated tension cracks form a double scarplet. These tension cracks enlarge, collapse, and erode to a moletrack-like feature (figure 5). Sinuous tension cracks in association with fresh scarplets along bench/scarp interfaces (photo 3) and slightly hummocky topography elsewhere to the north of this location further support the landslide explanation (figure 3).

The relatively ephemeral nature of the "moletrac " and open fissures (grabens) indicate that downslope movement had occurred at this location within a few months prior to the field check. Heavy rains during the late winter months no doubt caused the renewed downhill movement.

Similar landslide features (scarp and bench) can be observed on 1966 WRD air photos 1727 and 1728 (USGS), suggesting that downslope movement may be an on-going process (figure 3). Since geomorphic evidence of recent faulting cannot be found along the Harris Ranch fault trace northwest and southeast of this location, it is concluded that the moletrac observed by Rogers in the mid-1960's is related to landsliding rather than faulting.

6. Conclusions

San Andreas Fault

The San Andreas fault is generally well-defined in most of the FER study area and is delineated by geomorphic features indicating Holocene faulting (Rogers, in press; figure 3, this report). Fault creep is well-documented along the San Andreas fault in the study area (Tocher, 1960; Rogers and Nason, 1971; Nason, 1971; Schulz and Burford, 1979). The average rate of fault creep displacement of 0.45 to 0.5 inches per year has not changed significantly at the Almaden Winery in the last 30 years (Tocher, 1960; Schulz and Burford, 1979). Fault traces identified by Rogers (in press) and shown on figure 3 of this report adequately delineate the Holocene active traces of the San Andreas fault.

Harris Ranch Fault

There is no evidence for Holocene surface faulting along traces of the Harris Ranch fault of Rogers (in press), except for the northwestern-most trace that joins the main trace of the San Andreas fault (Smith, 1980; this report, figure 3). The moletrack observed by Rogers during field mapping in the mid-1960's is located in an area of active landsliding (figures 3, 5). A "moletrack" feature in the area reported by Rogers was observed by this writer during a field check in early May 1980. The "moletrack" was associated with a distinctive scarp-graben-bench sequence characteristic of active landsliding. It is concluded that the moletrack observed by Rogers was probably formed by landsliding rather than surface faulting.

7. Recommendations

San Andreas Fault

Rezone for special studies traces of the San Andreas fault shown on figure 6, based on Rogers (in press), and figure 3 of this report.

Harris Ranch Fault

Delete the fault traces shown on the 1974 SSZ Map of the Hollister quadrangle, except for those traces shown on figure 3.

8. Report prepared by William A. Bryant, 9-24-80.

William A. Bryant

I agree with the recommendations, although the SSZ boundaries should be drawn a bit narrower (see pencilled dashed lines on Fig. 6).
EWH
10/28/80

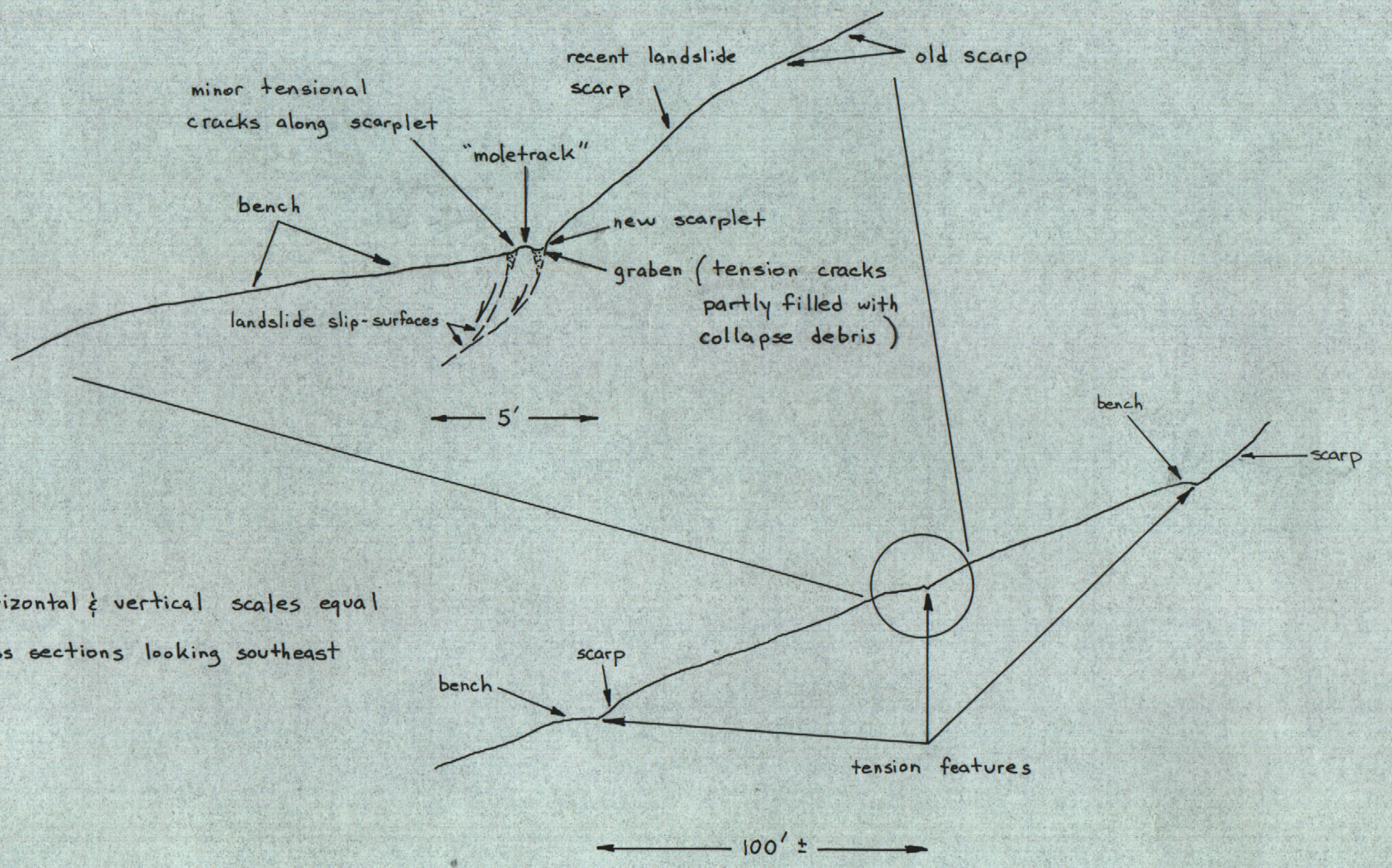

Figure 5 (to FER-99). Diagram of scarp-graben-bench sequence observed at location where Rogers mapped moletrack feature in mid-1960's. Observation by E. Hart and author made on May 1, 1980.

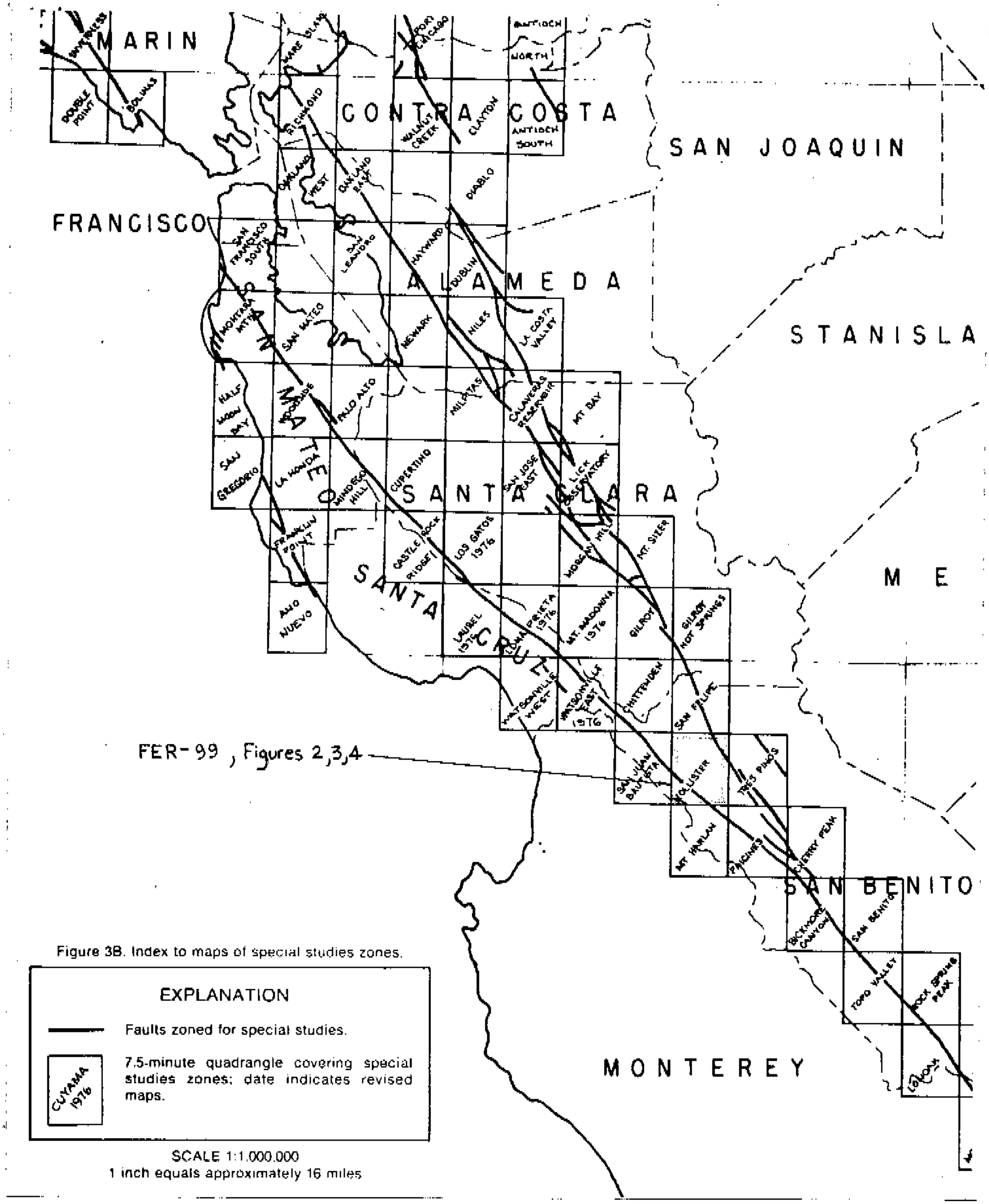

Figure 3B. Index to maps of special studies zones.

Figure 1 (to FER-99). Index to main faults and Special Studies Zones, Hollister quadrangle (from CDMG Special Publication 42, p. 13).

Photo 2 (to FER 99). Scarp-graben-bench sequence characteristic of the location of Rogers' moletrack; view looking southeast. Scarp is in the right part of the photo and the bench occupies the center and left part of the photo. The graben is situated at the base of the scarp where the observer is standing. Two additional sets of scarp-graben-bench features occur downslope (left) of this location (see figure 5).

Photo 1 (to FER 99). A sinuous "moletrack" feature observed during a field check, May 1980; view looking northwest. The feature was in the same general location as the moletrack observed by Rogers in the mid-1960's. The "moletrack" in the photo does not extend more than about 10 feet beyond the observer.

Photo 3 (to FER 99). Close-up of pull-apart graben located in vicinity of "moletrack" feature (see photo 1). The graben is located at the base of a scarp that is associated with landsliding.